ALTERNATIVES FOR AN AIR FORCE TRAINER: T-46 OR MODIFIED T-37

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Unless otherwise noted, all years referred to in this paper are fiscal years.

Details in the text, tables, and figures of this report may not add to the totals because of rounding.

All costs expressed in current dollars use the Administration's February 1986 economic assumptions.

PREFACE

Should the Congress add funding for the Air Force's new primary trainer, the T-46? Or would modifications to the current trainer, the T-37, suffice? How would such a decision affect the cost and capabilities of the trainer fleet? These will be important questions as the Congress continues debate over the Department of Defense budget for 1987. This analysis by the Congressional Budget Office (CBO) assesses the costs and effects of alternative procurement or modification profiles that could result from these decisions. The study was done at the request of the House Committee on Armed Services. In keeping with CBO's mandate to provide objective analysis, the study contains no recommendations.

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SUMMARY

Each year the U.S. Air Force trains about 2,100 new pilots. Early phases of that training currently take place in a T-37 aircraft. But the T-37 is old and lacks features the Air Force believes are important. So in 1982 the Air Force contracted with Fairchild Republic Company to produce a new trainer aircraft, the T-46. Fairchild, however, has suffered major losses due to cost overruns and management problems in developing the T-46. The Air Force has also had to hold down its planned spending. For these and possibly other reasons, the Air Force has not put any money into its 1987 budget for further purchases of the T-46 and is considering alternatives.

This paper analyzes the costs and effects of several alternative approaches that meet Air Force trainer needs, including:

- Continued procurement of T-46 aircraft;
- Major modification of existing T-37 aircraft coupled with purchases of some additional trainer aircraft other than the T-46;
- Minor modifications of the T-37 coupled with purchases of other aircraft.

The T-46 Approach

The T-46 would meet Air Force needs for a new trainer with a new, more capable aircraft. It would have a better engine than the existing T-37, a pressurized cockpit allowing flight at higher altitudes less congested with civilian aircraft, better bad-weather capability, improved ejection seats for safety, and other advantages like improvements in reliability and maintainability. These improvements, the Air Force argues, would allow the T-46 to provide better training for more hours per month than the existing T-37 but at less operating cost per hour.

Costs to design and buy 650 T-46s would total about $2.6 billion, more than the costs to modify the T-37s. Costs to operate the T-46 would, however, be lower than the T-37. Thus 20-year costs for the T-46 would total about $6.1 billion (see the Summary Table and Alternative I in the text). These costs include investment and costs to operate the fleet for 20 years (1987-2006), discounted at an annual real rate of 4 percent. (Alternative discount rates of 3 and 5 percent do not alter the relative rankings of the options considered in most cases.)

There is considerable risk of growth in T-46 investment costs, however. These investment costs reflect the funding that was included in the 1986 budget submission. Fairchild's cost difficulties in lot 1 of production suggest that actual investment costs could be higher than those assumed here, though it is difficult to assess the amount of the increase.

Major Modification of the T-37

An alternative approach would buy no more T-46s and instead make major modifications of the T-37 to give it many of the same capabilities as the T-46. These would include altering it to extend its service life into the next century, providing a new engine, pressurizing its cockpit, and improving its ejection seat and up-grading its avionics. In addition, this approach entails buying 100 of a new trainer to offset the limited size of the T-37 fleet. For specificity in costing, the new trainer is assumed to be additional purchases of the TTB trainer aircraft that the Air Force already plans to buy for other missions.

This option would eventually meet all Air Force requirements for training capacity with a modified T-37 designed to be nearly as capable as the T-46. It is not, however, identical in capability to the T-46 approach. Most importantly, this approach would not meet all needs until the mid or late 1990s because of the time needed to design and implement modifications and to buy the new TTB aircraft. The T-46--if it stays on the schedule assumed in last year's budget--would avoid most near-term shortfalls.

Given Air Force assumptions about the "utilization" hours that modified T-37s would be flown each month, total costs of this approach would be similar to those for the T-46, though investment costs would be

less. This approach would cost much less in investment over the next five years than continuing to buy the T-46 because it would take more time to accomplish the modifications and buy TTB aircraft than to buy new T-46s that are already designed and under construction. Total investment costs for this option would also be less than for the T-46 by 23 percent. Twenty-year costs, however, would be 2 percent higher because investment savings are offset by higher operating costs (see Summary Table and Alternative IV A in the text).

On the other hand, if the Air Force obtained improvements in utilization similar to those it expects for the T-46, this option would be substantially cheaper in terms of total investment (46 percent) and in terms of 20-year costs (16 percent). (See Summary Table and Alternative IV B in the text.) Currently, the Air Force believes that the T-46 can be operated 60 hours per month, but that the T-37—even though extensively improved—could not get above its current level of 45 hours per month. Since many of the factors that lead to assumed improvements in utilization of the T-46 are also part of this major modification, it would seem reasonable to expect some improvement in the utilization of the modified T-37, though it might be difficult to achieve 60 hours of monthly utilization. Absent a good assessment of potential utilization, this analysis shows both cases. In both cases, there should be less uncertainty about T-37 operating costs than about the T-46 because the Air Force has had extensive experience with the plane.

Minor Modifications of the T-37

If funds are stringent over the next few years, Air Force needs could be met at least partially through less extensive modifications of the T-37, such as modifications necessary to extend the life of the aircraft or those plus new engines. While these alternatives would be 35 to 69 percent cheaper in terms of total investment than continuing with the T-46 or making major modifications of the T-37, they would only be 3 percent to 12 percent cheaper in terms of 20-year costs as lower investment costs are offset by higher operating costs (see Summary Table and Alternatives I and II in the text). Moreover, in the long run, past the 20 years of this analysis, the advantages of lower investment costs would be outweighed by higher operating costs for these alternatives. Also, these more limited modifications

would not provide the improvements in safety and utilization that the Air Force believes are important.

SUMMARY TABLE. COMPARISON OF ALTERNATIVES

Alternative	Alternative Number in Paper	Investment Costs		Twenty-year Costs a/
		Next Five Years c/	Total b/	
Continue Buying the T-46	I	2.7	2.6	6.1
Major Modifications of the T-37 Plus Some New Aircraft				
--Assuming current T-37 utilization	IVA	0.4	2.0	6.2
--Assuming higher utilization	IVB	0.4	1.4	5.1
Minor Modifications of the T-37 Plus Some New Aircraft				
--Extending service life only	II	0.1	0.8	5.4
--Extending service life and reengining	III	0.3	1.7	5.9

a. In billions of 1986 dollars discounted at 4 percent.

b. In billions of 1986 dollars.

c. In billions of current dollars.

SECTION 1. INTRODUCTION

In 1982, the Air Force contracted with Fairchild Republic Company to begin producing a new trainer aircraft, the T-46. Fairchild, however, has faced problems developing the aircraft. Fairchild's costs for the first lot of 10 T-46 aircraft will exceed the amount budgeted by about 80 percent (an excess that Fairchild absorbed), and last year Fairchild had many discrepancies on a contractor review. For this reason, because of the fiscally constrained budget environment, and possibly for other reasons, the Air Force has not put any money into its 1987 budget for further purchases of the T-46. Instead, the service is considering alternatives to continued production of the T-46.

Some in the Congress have expressed strong preferences in regard to this program. In 1985, for example, the conference report of the House and Senate Appropriations Committees on the 1986 appropriation for the Department of Defense stated, "The conferees expect the Air Force to budget for and procure T-46 Aircraft in fiscal year 1987, where firm fixed price contract options are available, and in subsequent years to meet this critical and well justified requirement."

This paper analyzes the costs and effects of further production of the T-46 and other alternatives. After a background discussion about the uses of trainer aircraft, the paper analyzes requirements for trainer aircraft, for other aircraft that would be candidates for acceptance, and the costs and benefits of alternative approaches.

Section II. USES OF TRAINER AIRCRAFT

The Air Force has several programs that use trainer aircraft; the largest trains new U.S. pilots to replace departing pilots and to support increases in force structure. This training is called undergraduate pilot training (UPT) and is carried out by the Air Training Command (ATC). ATC also uses aircraft to train navigators and instructor pilots, provides additional training to co-pilots, and trains some NATO pilots.

Undergraduate Pilot Training

Before entering UPT, pilot candidates learn to fly a simple, propeller-driven T-41 aircraft during screening programs. Those who pass the screening go on to the "primary" stage of UPT and fly the T-37 aircraft at one of five Air Force training bases. The current training syllabus requires 76 flight hours on the T-37, during which a student pilot learns to fly the T-37, acquires some simple navigational skills, and engages in some formation flying. Students also spend about 33 hours using flight simulators.

About 86 percent of student pilots complete the primary phase and proceed to the "basic" phase of UPT, flying an average of 104 hours in the T-38--a more complicated and faster airplane--and an additional 34 hours on flight simulators. Training on the T-38 is similar to that on the T-37 though it includes more instrument and formation flying.

Graduates of the basic phase--about 94 percent of those entering it--receive their "wings" and proceed to their assigned operational commands. There they receive on-the-job training in operational aircraft.

In 1985, the total cost of putting a person through UPT was $340,000. In that year, about 1,800 active Air Force officers graduated from UPT. Two to three hundred others also graduate annually from UPT, including Guard and Reserve personnel and foreign students who do not fall under the NATO program mentioned above.

Other Uses

In addition to the UPT program, ATC provides T-37 aircraft to train Strategic Air Command copilots, who receive only limited flight hours as copilots of bombers and tankers. The Air Force believes that differences in operating costs make this a useful program. For example, B-52H costs per flying hour were about $15,000 in 1985 in comparison with 1986 costs of about $1,100 for the T-37. ATC also has an undergraduate navigator training program, that uses T-37 trainer aircraft. A Joint US-NATO pilot training program also increases aircraft requirements, though the Europeans provide some aircraft. Instructor pilots for each of these programs must be trained as well.

SECTION III. TRAINER REQUIREMENTS

Quantification of the requirements for trainer aircraft depends basically on the number of hours of training required per pilot and the hours per month that a trainer aircraft can be flown. Estimates below reflect the following key assumptions made by the Air Force:

- Undergraduate pilot training will be provided to about 1,700 active pilots per year over the next five years, slightly down from an average of about 1,740 for the period 1981 through 1985;
- Training hours per pilot for undergraduate pilot training will increase to about 200 from the current 180 hours, reflecting the revised syllabus discussed below; 1/
- Requirements are expressed in terms of T-37 aircraft, and so assume 45 hours of operation per aircraft per month.

The Trainer Shortfall

Figure 1 compares requirements for trainer aircraft with the projected inventory. (Table 1 breaks out the total requirements into the various programs that generate them.) As can be seen, the service had a shortfall equivalent to about 10 T-37 aircraft at the end of 1985. That shortfall increases gradually in the late 1980s as the Air Force increases its planned flying hours and the projected inventory of T-37s falls slightly because of peacetime accidents. 2/ The shortfall increases very rapidly by the early

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1. Hours will depend upon the prospective missions of the student pilots, and will range from 192 to 198.

2. The rapid decline in T-37 inventory from 1986 to 1987 resulted from a transfer of 29 T-37s to Tactical Air Command (TAC) to perform TAC's forward air control mission.

TABLE 1. AIRCRAFT REQUIREMENTS, 1987-1995

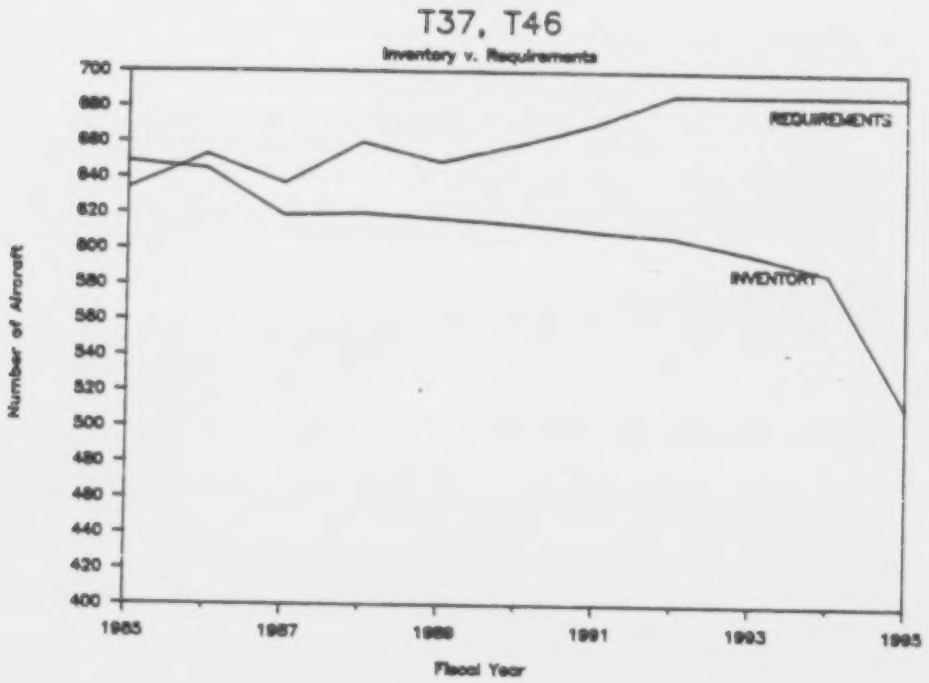
Program	87	88	89	90	91	92	93	94	95
Undergraduate Pilot Training (UPT)	409	423	425	436	448	464	464	464	464
Instructor Pilot Training	49	49	49	49	49	49	49	49	49
NATO Program	86	96	84	83	83	83	83	83	83
Undergraduate Navigator Training (UNT)	31	29	28	28	28	28	28	28	28
Accelerated Copilot Enrichment (ACE) (For Strategic Air Command)	62	62	62	62	62	62	62	62	62
Total Requirement	637	659	648	658	670	686	686	686	686

SOURCE: Congressional Budget Office estimates based on Air Force flying hour program.

Assumptions:

- Eight percent additional aircraft are added for the maintenance pipeline.
- Aircraft are operated 11.7 months per year for all programs except ACE, for which 12 months of operation are assumed.
- Aircraft utilization rate is 45 hours per month.

FIGURE I



SOURCE: Congressional Budget Office Estimates from Air Force data.

Assumptions:

Requirements

- o ATC's currently programmed flying hour profile.
- o 8% additional aircraft for maintenance pipeline.
- o Aircraft operational 11.7 months per year.
- o Aircraft utilization rate of 45 hours per month.

Inventory

- o 10 T-46 aircraft funded in FY 1985 but no further T-46 deliveries.
- o 0.7 attrition rate per 100,000 flying hours.
- o Includes 35 German planes used in the Europe NATO Joint Jet Pilot Training Program.

1990s when large numbers of T-37s reach the end of their 18,000-hour, 36-year life and are scheduled to be retired.

Importance of the Shortfall

If the Air Force does nothing to add to its inventory of aircraft, one or more of several actions will have to be taken: some training programs described above will have to be terminated; the flying hours in the current syllabus will have to be reduced, rather than increased as is currently planned; or pilot production will have to go down. Any such changes, the Air Force argues, will reduce operational effectiveness.

The Air Force indicates, for example, that history shows reductions in flying hours per pilot would greatly harm training. The current syllabus is about 10 hours above the Air Force's historical minimum of 170 hours per pilot in 1977. Air Training Command states that commands receiving graduates at that time found some of them unable to pilot operational aircraft without additional training. Particular deficiencies were found in instrument flying, which had been removed from the flying syllabus. These deficiencies had to be made up with additional training in operational aircraft at substantially higher costs per flight hour. The Air Force also believes that additional simulator flying would not take the place of actual flying hours, on the basis of experience in 1977.

Rather than decreasing flying hours per pilot, the Air Force argues that they should be increased from their current 180 hours to about 200. The desired increase is associated with a revision in the training syllabus. Currently, those who complete the primary phase of undergraduate pilot training go on to basic training in the higher-performance T-38. Under the revised syllabus, those who will eventually fly high-performance aircraft--including fighter, attack, and reconnaissance aircraft—will continue to train on the T-38 for the basic phase. But those who will eventually fly tanker, transport, or bomber aircraft will not receive basic training on the T-38 but rather on a new aircraft--yet to be purchased--that is designated the tanker-transport-bomber aircraft or TTB. The net result of this revision of the syllabus will be an increase in flying hours per pilot.

Nor can other programs using T-37 aircraft be cancelled to reduce requirements, the Air Force argues. For example, should the Strategic Air Command be forced to cancel its program that uses T-37s to provide training to bomber and tanker copilots, then either the copilots would be less able or they would have to train on operational aircraft at substantially higher costs per flight hour.

Finally, pilot production probably cannot be further reduced to overcome a trainer shortfall. Direct production rates of undergraduate active Air Force pilots are assumed to be slightly lower over the next five years than they have been over the past five years, averaging about 1,700 pilots per year compared to an average of about 1,740 for 1981 through 1985. Further reduction might therefore adversely affect capability, especially if a recent trend toward lower pilot retention continues.

As this discussion suggests, the Air Force appears to have reasonable arguments for all of the T-37 requirements displayed in Figure 1. On the other hand, there may be some flexibility. For instance, Figure 1 shows that the Air Force is currently short about 10 planes or 2 percent of the T-37 aircraft that it requires. Yet training is being conducted, apparently successfully, though probably with more strain on trainers and trainees than if more aircraft were available. It may also be possible to delay or avoid planned increases in flying hours, thus minimizing the shortfall. This paper uses the requirements in Figure 1 as a basis for assessing alternatives but recognizes the possibility of some flexibility.

SECTION IV. AIRCRAFT THAT COULD MEET TRAINING REQUIREMENTS

Numerous types of aircraft could meet Air Force needs. This section briefly describes the aircraft analyzed in this paper. Others might also meet these needs but are not analyzed here for reasons noted at the close of the paper.

The T-37

The current primary jet trainer, the T-37 is a twin-engine, turbojet, two-seat airplane. The T-37's two seats are located side by side, a configuration the Air Force wants because of the advantages of learning by watching. It has a top speed of 370 knots and a maximum altitude of 25,000 feet. (Table 2 provides a description of the characteristics of current and planned trainer aircraft.) The altitude limitation is due at least in part to the fact that the plane is not pressurized.

T-37s have been in the Air Force inventory since 1956, when the service began buying a total of about 950. Of this number, about 610 remain in the U.S. inventory; 35 German T-37s are also used by the command in the NATO training program.

The T-46

In the late 1970s the Air Force became concerned that the T-37 inventory would be insufficient to meet its requirements. In addition to a shortage in numbers of aircraft, the service was concerned about operational deficiencies with the aircraft itself and that the plane would soon reach the end of its service life.

History. The Air Force conducts its Undergraduate Pilot Training at five training bases. The airspace around them, according to the service, is becoming increasingly congested with civilian traffic, causing missions to be aborted because of aerial traffic jams. Other aborts occur because of weather conditions. If the primary trainer was pressurized, the service reasons, training could take place at higher altitudes, where fewer civilian aircraft fly. And if its range was increased, pilots could plan to divert to bases with better weather conditions, increasing the number of flights that could be made in inclement weather.

In addition to these factors there were other problems, associated in part with the age of the T-37. Among them:

- Limited ejection seat capabilities—the T-37's ejection seat is not designed to work at certain low speeds and altitudes;
- Lack of commonality with current instrumentation—the T-37 does not, for example, have the digital instrumentation common in today's aircraft;
- Excessive fuel requirements and the number of hours needed to maintain the aircraft; and
- Excessive noise.

In 1979 the Air Force issued a "statement of need" for a new trainer. The plane envisioned would continue to have the side-by-side seating and twin jet engines of the T-37, but the deficiencies noted above would be met. After a hiatus of three years during which the service answered Congressional concerns that this Air Force requirement could be met by buying a Navy trainer, Fairchild Republic Company received the contract to build the "next generation trainer," eventually designated the T-46.

Description. The T-46 is a twin turbofan-engine plane with side-by-side seating (see Table 2). It has a range of about 1,200 nautical miles and a pressurized cockpit. It also has improved ejection seats and instrumentation to meet the Air Force statement of need. In addition, the T-46 is designed to use less fuel per mile than the T-37 and to be easier to maintain and to refuel. For these reasons, the T-46 is expected to have lower operating costs than the T-37.

TABLE 2. AIR FORCE TRAINER AIRCRAFT PROFILES

	T-37 Current Primary Trainer	T-46 Primary Trainer Replacement	TTB Basic Trainer For Multi-Engine Pilots
Inventory at End of Procurement	610 a/	650 b/	200 c/
First Entrance to Fleet	Late 1950s	Late 1980s	Early 1990s after off-the-shelf commercial procurement
Operational Characteristics			
Range	500 nautical miles d/	1210 nautical miles	To be determined
Speed	370 knots	430 knots	To be determined
Engines			
Number	2	2	Multiple
Type	J-69 Turbojet	F-109 Turbofan	Turbofan
Maximum Altitude	25,000 ft	47,000 ft	To be determined
Accommodation Seating	2 Side by side	2 Side by side	3 2 side by side 1 centerline

SOURCES: Jane's All the World's Aircraft, 1974-1975 and 1985-1986 editions, and U.S. Air Force.

a. Total remaining in the U.S. inventory in 1985.

b. Procurement total in fiscal year 1986 budget submission. Budget for 1987 contains no further procurement.

c. Total procurement.

d. Source: Cessna Aircraft Company.

In 1985, 10 T-46s were purchased at a total program cost of $200 million, and these are currently being produced. 3/ Another $260 million in total program costs to buy 33 more T-46s was authorized and appropriated by the Congress in 1986.

Despite these investments, the 1987 budget contains no request for funding for this aircraft, and the Air Force is undecided as to whether it will use the $260 million provided last year by the Congress for continued T-46 development and procurement for that purpose. 4/ While the Air Force had originally intended to buy 650 T-46s through 1990, cost growth, schedule slippage, and management problems at Fairchild Republic have made the survival of the program uncertain, though the Air Force maintains that its major concern is the current constrained budget environment. Lot 1, the 10 aircraft funded in 1985, will cost Fairchild about 80 percent more to produce than the company budgeted. Production is currently eight months behind schedule. Fairchild maintains that many of its problems have been solved, though it acknowledges that the schedule and costs associated with last year's budget are optimistic.

A Modified T-37 Aircraft

Another approach to meeting trainer requirements would involve modifying the T-37 aircraft. These modifications would extend its life for another 10,000 to 15,000 flight hours, enough to allow it to remain in the inventory into the next century at current rates of utilization. The modifications would be done by the winner of a future competition.

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3. Total program costs include procurement and research and development funding and long-lead funding for the following year. Procurement costs in each of these years were $125 million and $212 million respectively (also including long-lead funding).

4. Indeed, the Procurement Programs annex to the 1987 budget contains no funds in fiscal 1986 for the plane.

In addition to extending its life, modifying the T-37 could add capabilities desired by the Air Force. Three approaches have been proposed:

- o Service life extension, including such items as strengthening the airframe and tail;
- o Service life extension plus reengining; and
- o Service life extension, reengining, and upgrading of capabilities to more closely meet the Air Force statement of need.

The Tanker-Transport-Bomber Trainer (TTB)

The TTB is another aircraft that could meet some of the needs now met by the T-37; indeed, the Air Force expects to buy 200 of them, though they are intended for the basic phase of undergradute pilot training. As was noted above, the Air Force intends to modify the syllabus for its basic phase of undergraduate pilot training. Those pilots who will eventually fly tankers, transport aircraft, or bombers will no longer train on the higher-performance T-38 during the basic phase of undergraduate training; instead they will train on a new aircraft, the TTB. But additional TTBs would meet other needs relevant to this paper, such as the Strategic Air Command's need to train its copilots.

The exact specifications for the TTB, which the Air Force does not intend to begin purchasing until 1989, are not yet firm. Currently, however, it is intended to be an off-the-shelf aircraft similar to those used for corporate transportation. The TTB will, at a minimum, contain multi-engines and three seats.

SECTION V. ALTERNATIVES THAT WOULD MEET TRAINING NEEDS

Several packages of aircraft could meet Air Force needs. Alternatives considered in this analysis include buying the T-46 aircraft, as the Air Force originally planned, or modifying the existing T-37 fleet of trainers coupled with the purchase of some new aircraft.

All the alternatives discussed in this section would eventually meet Air Force training needs, though some of them would leave the Air Force short of trainers for the next few years at least. All the options would also add to the proposed Administration budget, which included no funds for primary trainer aircraft. Costs and other data are generally based on Air Force rather than contractor data.

Alternative I: Continue Buying T-46 Aircraft

The Congress could continue buying T-46 aircraft to meet Air Training Command requirements for additional aircraft, and to solve the problem of T-37 deficiencies. This alternative assumes that 607 T-46 aircraft are bought over the next five years. Thus it returns to last year's Administration program (see Table 3). Informal discussions have suggested that the Air Force is considering delaying the program and buying substantially fewer T-46s over the next few years, but detailed data needed to analyze this option were not available.

The major advantage of this alternative is that it would meet ATC's aircraft needs with new, more capable planes. The T-46, according to ATC, would have a higher utilization rate--60 hours per month in comparison to the T-37's 45 hours--because it is easier to maintain and avoids limits on utilization such as those caused by airspace congestion or weather. Thus fewer aircraft would be needed to meet requirements. The plane is also projected to have substantially lower operating costs than the current aircraft because of lower costs for fuel and maintenance.

The pressurization of the new T-46 trainer would moderate potential problems associated with airspace congestion and make flying a less taxing

TABLE 3. DESCRIPTION OF ALTERNATIVES

	Alternatives	Aircraft	Total Procurement Quantity		Monthly Hours of Utilization	Squadrons/ PAA per Year a/
			Next 5 Years	Total		
I.	Continue T-46 Procurement	T-46	607	650	60	7/68
II.	Modify T-37 to Extend Service Life	T-37 TTB	280 0	645 100	45	8/68 1/87
III.	Modify, and Reengine T-37	T-37 TTB	136 0	645 100	45	8/68 1/87
IVA.	Modify, Reengine, and Upgrade T-37	T-37 TTB	136 0	645 100	45	8/68 1/87
IVB.	(With Higher Utilization)	T-37	136	645	60	7/68

a. Because of the differing utilization rates for planes, CBO assumed that differing force sizes would need to be operated in order to fly the same number of hours. Primary Aircraft Authorization (PAA) is the number of aircraft per squadron.

TABLE 4. INVESTMENT COSTS OF ALTERNATIVES I-IV a/
(All costs are in billions)

	Alternatives		Investment Costs 1987-1991 (In current dollars)						Total Investment Costs (In current dollars)	Total Investment Costs (In 1986 dollars)
			1987	1988	1989	1990	1991	1987-1991		
I.	Continue T-46 Procurement	Quantity	99	144	144	144	76	607	650	650
		Cost	0.6	0.7	0.6	0.6	0.3	2.7	2.9 b/	2.6 b/
II.	Modify T-37 to Extend Service Life	Quantity	0	0	24	112	144	280	745 c/	745 c/
		Cost	0	d/	d/	d/	d/	0.1	1.1 c/	0.8 c/
III.	Modify and Re-engine T-37	Quantity	0	0	0	24	112	136	745 c/	745 c/
		Cost	0	d/	d/	0.1	0.2	0.3	2.2 c,e/	1.7 c,e/
IVA.	Modify, Reengine, and Upgrade T-37	Quantity	0	0	0	24	112	136	745 c/	745 c/
		Cost	0	d/	d/	0.1	0.3	0.4	2.6 c,e/	2.0 c,e/
IVB.	(With Higher Utilization)	Quantity	0	0	0	24	112	136	645	645
		Cost	0	d/	d/	0.1	0.3	0.4	1.7 e/	1.4 e/

SOURCE: Congressional Budget Office estimates from fiscal year 1986 budget submission and Air Force data.

a. Numbers may not add to totals because of rounding.

b. Estimate includes $0.3 billion provided by the Congress in 1986 for procurement of 33 aircraft, but excludes funding for 1985 and prior years as sunk costs.

c. Cost and quantity includes funding for 645 T-37 modifications and 100 TTB aircraft. TTB costs total $0.6 billion in constant 1986 dollars and $0.9 billion in current dollars. As CBO assumed that TTB procurement would be added to the end of the current profile, five-year costs contain no TTB funding.

d. Less than 100 million.

e. Includes about $0.6 million in 1986 to begin engineering estimates.

physiological experience for students and pilots. The T-46 should also be safer because its ejection seats would function in almost all of the flight envelope.

The major disadvantage is that the alternative would be expensive in the near term. Research and procurement would require at least $0.6 billion in additional funding in 1987, and $2.7 billion over the next five years (see Table 4). These costs are based on last year's Administration budget. Actual procurement costs for the T-46 could be higher. As was noted above, Fairchild's costs for Lot 1 of the T-46 will exceed the contractor's budget by about 80 percent; recurring costs for Lot 1--which might most affect future procurement--will exceed the budget by about 30 percent. Since Fairchild's costs account for about half the total aircraft cost (the rest pays for the engines and other equipment), the experience with Lot 1 might suggest that costs could increase above those shown by 15 to more than 30 percent. Costs could also increase further if the Air Force decides to buy T-46s more slowly.

While near-term costs of investment are important, the longer-run costs of decisions are also important. Table 5 shows twenty-year costs for the T-46 option, defined as costs over the next 20-years (1987-2006) to buy T-46 aircraft and to operate the T-46s plus T-37s until they are replaced. An Air Force model, using Air Force and CBO inputs, suggests that each T-46 will cost about $0.5 million a year to operate once fully in service. 5/ This implies that the cost to buy 650 T-46s and to operate ATC's primary trainer fleet for 20 years amounts to about $6.1 billion.

While these 20-year costs are a reasonable guide to long-term costs, the long time over which they are estimated causes them to be somewhat uncertain. One source of uncertainty is the discount rate that is used to reflect the preference for money now rather than later. The costs shown above are discounted in real terms (1986 dollars) at a rate of 4 percent a year. 6/ The absolute values for the costs are very sensitive to this rate. A

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5. The Air Force provided inputs that enabled CBO to arrive at a cost for each flying hour. Assumptions about the number of hours flown and the number of squadrons operated were calculated by CBO based on various assumptions about utilization rates.

6. Discounting is a way to calculate, in today's dollars, the value of a future expenditure or future stream of annual expenditures--in this

1 percent change in the rate yields a $300 million change in the total cost for this alternative. Thus, at a lower discount rate of 3 percent, the alternative costs would total $6.4 billion; at 5 percent, costs would be $5.8 billion. 7/ (Tables 1 and 2 in Appendix B show twenty-year costs of all the alternatives at 3 and 5 percent discount rates.) Relative rankings of options are less affected.

Nor are the discount rates the only source of uncertainty. Should T-46 investment costs increase as earlier discussed, 20-year costs would be substantially higher. Operating costs could also change. The Air Force has never operated a T-46 in an operational setting and so has no actual cost data. The operating costs in Table 5 are estimates made during development; such estimates are frequently optimistic. Fairchild argues, however, that a more detailed modeling of operating costs for T-46 than was originally done at source selection would substantiate, even reduce, these estimates. Additionally, operating costs are affected by factors like the price of fuel for which estimates are speculative, though the results of this analysis are relatively insensitive to small changes in fuel prices.

Alternative II: Extend the Service Life of the T-37

Because of the expense of Alternative I, and possibly concern over

Footnote Continued

case, investment and operating costs. The result is called present value. A future expenditure is discounted to its present value using the following formula:

$$\text{Present Value} = \text{Future Value} / (1 + i)^n,$$

Where n = the number of years between the present year and the year in which the expenditure is made, and i = the discount rate. The discount rate used in this analysis is 4 percent in real terms.

7. Some uncertainty exists concerning the appropriate values for this rate. For a discussion of discount rates, see Congressional Budget Office, Pricing Options for the Space Shuttle, (March 1985), p. 15. As the rates relate to the assumed real interest rate which is currently projected by CBO to fall, the analysis also provides a calculation at 3 percent. See Congressional Budget Office, The Economic and Budget Outlook: Fiscal Years 1987-1991, pp. 1-4.

Fairchild's operating problems, the Congress might consider other options to meet Air Force trainer needs. It might, for example, choose to forego procurement of the T-46 trainer aircraft and instead continue to rely mostly on the T-37, supplemented by some new aircraft to meet current and expected shortages. Specifically, DoD would purchase no more T-46s, cancelling Lot 2 of the 1986 buy and all further purchases. Instead, it would undertake six basic modifications of the T-37 to extend the service life of existing aircraft. These modifications would include strengthening the tail section and the wings of the plane plus other alterations (see Appendix A for a detailed description). These modifications would, according to the Air Force, extend the service life of the T-37 by 10,000 to 15,000 hours, allowing it to fly--at current rates of utilization--for another 20 years.

As was noted above, however, the existing fleet of T-37 aircraft does not meet all current Air Force needs, and shortages would grow. To meet these shortages, this option calls for the purchase of about 100 new aircraft which, for specificity in costing, are assumed to be the TTB aircraft planned by the Air Force. 8/ These 100 TTBs would be needed in addition to those purchased for other Air Force missions. Under this option, the 100 TTBs would be purchased in the 1990s, after other TTB needs were met. The TTB aircraft could be used, for example, by the Strategic Air Command for its copilot training, thus freeing the T-37s now used in that ACE mission to meet training shortfalls.

The TTB would not be the only aircraft that could be purchased, and its costs might be higher than other alternatives. For example, Cessna argues that the costs of buying new T-37's (the so-called new technology T-37 that contains the additions in capability discussed in Alternative IV) would be lower than those assumed here, and that operating costs of new T-37s could be substantially lower than those of the T-39, which was used as a proxy for the TTB. CBO is unable to estimate the effects of these alternative assumptions because of time constraints and the absence of Air Force funding estimates.

The major advantage of this alternative is that it would be relatively inexpensive in the near term, costing approximately $100 million over the next five years. Little or no funding would be required in 1987 because this

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8. CBO assumed that the marginal cost to the government for each of these aircraft would average $6.4 million in constant 1986 dollars.

modification is relatively simple and could be designed and implemented before T-37s begin to reach the end of their service lives, even if funding did not begin until 1988. 9/ Near-term costs would be low because this alternative's modifications would be relatively cheap and because the additional 100 TTB aircraft would not be purchased until the 1990s. Total investment cost would be about $0.8 billion excluding inflation, still much less than under Alternative I. Modification costs for this option are based on estimates provided by the San Antonio Air Logistics Center.

While near-term costs would be substantially lower than those for Alternative I, total discounted 20-year costs of this alternative would be about $5.4 billion, lower by only 11 percent than under Alternative I. This is because the T-37's lower investment costs offset the higher operating costs of the plane and because the costs of buying and operating the additional 100 TTB aircraft as well as the additional squadron of T-37 aircraft occur in the mid-to-late 1990s. 10/ Over the very long run---past the 20 years of this analysis—the option's higher operating costs should offset investment costs and yield a higher life cycle cost. As with Alternative I, estimated operating costs are based on an Air Force model and use Air Force and CBO input factors. (Air Force input factors assume a constant price per gallon of gasoline. If these prices were to fall, the T-37's more fuel-inefficient

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9. The costs of all T-37 modification options reflect informal estimates from the Air Force. The numbers were provided by the San Antonio Air Logistics Center at Kelly Air Force Base. Air Training Command also provided estimates discussed later. One relatively minor disagreement between the Commands concerns the timing of the funding required. ATC felt that funding on the order of $10 million to $11 million would be required in 1987 for all modification options, while Kelly felt that no funds would be needed or could be spent in this first year of the program. Both Commands agree that about half a million dollars would have to be reprogrammed in fiscal year 1986 to begin engineering studies for Alternatives III and IV. These numbers are not budget-quality numbers and should be taken as preliminary estimates.

10. It would be possible to form an additional squadron of T-37 aircraft--eight T-37 squadrons rather than seven of T-46—from the same total number of planes because the attrition rates are higher for the T-46 than for the T-37, according to Air Force projections.

engine would be at less of a disadvantage--though the impact on the overall ranking of options is slight.)

Though this alternative costs less in the 20-year period of the analysis, it does not meet the performance requirements of the T-46. Specifically, T-37s would still be noisy, unpressurized, and unable to fly in bad weather; their ejection seats would still be unusable in certain parts of the flight envelope. Should ATC's concerns about increasing civilian traffic materialize, training usage also could fall because these modified T-37s would not be able to fly at altitudes that are less crowded but require pressurization. In addition, T-37s under this alternative might continue to be slightly underpowered. This would make it difficult for a T-37 that had lost the use of one engine to gain altitude on a hot day, which poses a potential safety problem, especially when combined with the ejection-seat limitation. 11/

In addition, the estimated modification costs of this alternative may be too low. The costs given were based on estimates from Kelly Air Force Base, but other estimates from the Air Training Command, which included upgrades to the J-69 engine, were about 50 percent higher than Kelly's. Though inclusion of ATC's estimates would not be likely to change the ranking of the alternatives, they suggest some uncertainty in these costs as well.

Moreover, this alternative would continue to rely on an old aircraft. The T-37s would be expected to remain in the inventory until many were 40 to 50 years old. It is difficult to appraise the reliability of such old aircraft, since the Air Force has had little experience operating airframes of that vintage.

Finally, this option would not solve the near-term shortage of trainer aircraft. That shortfall would remain until the mid-1990s, when new TTB aircraft enter the inventory. 12/ Indeed, the near-term shortfall could be

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11. Teledyne CAE says that this difficulty, associated with its J-69 turbojet engine, can be remedied at modest cost. The option contains funding for an engine overhaul, but no funding for improvements in engine capability, though this additional funding is discussed later.

12. The length of this shortfall will depend upon when TTB aircraft become available for the ACE program, rather than being limited to

exacerbated by removal of T-37s for modification.

In sum, this option's main advantage is that it would cost little in the near term. While this might be important in a period of intense fiscal restraint, the approach would fail to solve many of the problems that led the Air Force to buy a new trainer.

Alternative III: Reengine and Extend the Service Life of the T-37

To address some of these problems, Alternative III would perform the modifications described in Alternative II plus reengining each T-37 with the Garrett F109 turbofan engine, the same engine planned for the T-46. As in Alternative II, 100 new TTB aircraft would be purchased.

This alternative addresses some of the performance concerns of the ATC. Modifications to extend service life would allow the aircraft to operate an additional 10,000 to 15,000 hours, as in Alternative II. In addition, reengining should allow the aircraft to meet ATC's safety concerns relating to single-engine performance during hot weather while also reducing fuel usage and noise levels. Operating costs for a reengined T-37 should also be lower, although not as low as for a new T-46.

Investment for this option would be more expensive than in Alternative II but less than in Alternative I. Investment costs would be $0.3 billion over the next five years. Little or no funding would be required in 1987, because of the lead time necessary to design the modifications, but an additional $0.6 million might have to reprogrammed in 1986 to allow engineering efforts for the reengining to begin. Near-term investment costs would be low and total procurement costs for this option would be about $1.7 billion—still less than Alternative I by 35 percent—though higher than those of Alternative II.

Moreover, 20-year costs for this option would be higher than under the previous option. Costs would total about $5.9 billion. The 20-year costs would be higher than under Alternative II, which makes minimal modifications of the T-37, because the added costs of reengining would more than offset the lowering of operating costs that would result. Twenty-year costs of this option would be slightly lower than those of Alternative I,

Footnote Continued

the basic phase of the UPT program.

which buys the T-46, despite the T-37's higher operating costs and the costs of operating the additional 100 TTB aircraft, because some of the costs would occur in the mid-to-late 1990s, as with Alternative II. As with the previous alternatives, procurement costs are based on Air Force estimates while operating costs were estimated using an Air Force model with Air Force and CBO inputs.

Though this alternative would cost slightly less in the long run, it would continue to rely on an old T-37. Many of the new aircraft performance requirements desired by ATC would not be met. Altitude limitations would remain, since the plane would not be pressurized. Nor would there be any change in the useful envelope of the ejection seats, though the increase in power should enable a student to gain altitude or speed even with one engine out, thus reducing the likelihood of having to eject at a point where the current seat does not work.

Near-term aircraft shortfalls could also be substantial under this option, perhaps greater than under Alternative II. This modification is more extensive and would take longer to complete than Alternative II, thus leaving fewer aircraft available for pilot training.

For this option, the discount rate chosen is important to its ranking. With a lower rate--say 3 percent--the option would be slightly more expensive than Alternative I in the long run, with 20-year costs of $6.5 billion. (See Table B-1 in Appendix B.)

In sum, this option provides a middle ground between Alternative I, with its high up-front cost but substantial improvement in capability, and Alternative II with its low up-front costs but minimal improvement in capability. Nonetheless, this approach still does not meet the Air Force's stated needs for improvements in a trainer.

Alternative IV: Extend the Service Life of the T-37 and Upgrade It

Modifications proposed under this alternative would significantly upgrade existing T-37s to meet Air Force needs and purchase an additional 100 TTB aircraft to meet aircraft shortfalls. In addition to reengining and the improvements necessary to extend the T-37 service life, modifications would include cockpit pressurization, a new ejection seat, new controls and avionics, and some improvements in the plane's environmental control systems (primarily improving air conditioning). (See Appendix A.)

These modifications should meet most of the requirements listed by the Air Force in its statement of needs. The new engine would cut operating costs and improve safety. The pressurized cockpit and better performance in bad weather should improve utilization. The new ejection seat would be safer, though it would not have quite the capability of the T-46 ejection seat. And the instrumentation would make this modified T-37 more like modern aircraft.

Nonetheless, this option is not equal in capability to Alternative I. Near-term shortfalls of aircraft would continue until the mid-1990s. This option would also continue to rely on old T-37s, albeit extensively modified and updated. And it would not buy a new aircraft. Thus it could require the purchase of a new aircraft earlier than would Alternative I. But the Air Force does believe that the need to replace T-37s modified under this option would not occur until well into the next century.

In sum, while not equal in capability, this approach is much closer to the first one in capability than either of the other two. Thus its costs provide a better comparison with the T-46 option.

Costs results depend upon assumptions about utilization—the hours per month that the aircraft can be flown. Utilization reflects how much the Air Force needs to fly but also, given that demand is likely to be heavy, ease of maintenance, speed of ground turn-around refueling time, ability to fly in poor weather, and other factors.

Under Air Force assumptions about utilization of the modified T-37, the total costs of this option would be similar to the T-46, though investment costs would be less. Five-year costs for this alternative modification of the T-37 would be $0.4 billion, substantially less than for the T-46. As with Alternative III, no funds would be required in 1987 because the year would be spent designing modifications.

Total investment costs for Alternative IV would be about $2.0 billion, including the costs of 100 TTB aircraft. These costs are about 23 percent less than those of the T-46 alternative. But, the total discounted twenty year costs of this approach, at $6.2 billion, are slightly higher than those of the T-46. Thus in the long run the reduced operating costs that the T-46 is expected to experience would offset its higher investment cost. This would occur despite the fact that the phasing of the alternative means that CBO's 20-year analysis cannot capture the total costs as with Alternatives II and III.

The choice of different discount rates alters these results modestly. A lower discount rate of 3 percent would produce a 20-year cost of $6.8 billion, about $0.4 billion higher than the costs of Alternative I. A higher discount rate of 5 percent would make the alternative less expensive at $5.7 billion.

The investment and 20-year costs of the T-37 would, however, be highly dependent upon the utilization rate assumed for the aircraft. Air Training Command argues that, despite substantial modifications, the utilization of the T-37 would remain at 45 hours per month, the same as for the unmodified T-37. Yet the T-46 is expected to have a 60-hour utilization rate. Thus this option must buy 100 additional TTB aircraft to meet Air Force needs. If the modified and reengined version of the T-37 could achieve the same utilization rate as the T-46, then its 20-year costs discounted at 4 percent would fall to $5.1 billion, about 16 percent less than those of the T-46. This occurs because assumptions about utilization affect both procurement costs and operating costs. With higher utilization this option would not need to buy any TTB aircraft, nor would it need to operate them or the additional T-37 squadron.

Which utilization assumption is correct? There is reason to expect at least some improvement in the utilization of a modified and reengined T-37 though CBO cannot determine how much. The expected improvements in utilization of the T-46 occur at least in part because of the factors that this alternative would remedy--like pressurization and better bad-weather performance. Nor has the Air Force always assumed a 45-hour rate for the T-37. An Air Force study done by Air Training Command in May 1981 assumed a 50-hour utilization rate for an unmodifed T-37. More important, a study done by the Analytic Services Corporation for the Air Force in October 1981 assumed a 56-hour utilization rate for a reengined and modified T-37 similar to the one in this option. 13/ On the other hand, it might be difficult to achieve a 60-hour utilization rate for the modified T-37, which does not have all the new features of the T-46. Given the absence of a good assessment of potential utilization for the modified T-37, this analysis showed the effect of both the 45-hour and 60-hour assumptions.

The T-37 would also have the advantage of less uncertainty about

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13. Air Training Command, U.S. Air Force, An Evaluation of the T-34C as a Next Generation Trainer Alternative, (May 1981) and George E. Thompson, Operational and Economic Analysis of Options for Air Force Primary Training Aircraft, Analytic Services, Inc. (October 1981). The Answer study also assumed a 65 hour utilization rate for the next generation trainer as the T-46 was then called.

operating costs, since it is an aircraft that the Air Force has operated extensively. Investment costs are, however, somewhat uncertain under this alternative. CBO received total modification costs from Air Training Command for this more extensive modification that are about 13 percent higher than those used in this analysis. Should these costs prove accurate, both investment and 20-year costs could go up.

ALTERNATIVES NOT ADDRESSED

Other alternatives exist that have not been considered in this study. In particular, the Air Force has received an unsolicited proposal from a Brazilian firm, Embraer, for a trainer called the Tucano. The press has also discussed several other foreign aircraft, as well as the Navy T-34 trainer. 14/

In the past the Air Force has argued strongly for side-by-side seating and two jet engines in its primary trainer aircraft. This requirement would rule out the T-34 and Tucano. Indeed, in 1982 the Congress wanted the Air Force to consider buying the Navy T-34s. Several Air Force studies at the time indicated that--because of single-engine performance, differences between propeller and jet performance, and reductions in learning because of lack of side-by-side seating--the overall costs of a training syllabus flown in part on the T-34 would be higher than costs using the T-37 or T-46. 15/ The Tucano, which is a single-engine turboprop plane without side-by-side seating, would appear likely to generate the same Air Force concerns. Should the service change these requirements, then the Tucano or similar aircraft could be considered.

Additionally, the Air Force has received a letter offer from the Cessna Corporation for the new reengined and upgraded T-37 aircraft, discussed earlier. Should the Air Force stop buying T-46s and reopen bidding for a trainer, this plane could clearly be a contender.

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14. See for example "Grumman Corporation Ends Negotiations to Purchase Fairchild Republic," Aviation Week and Space Technology, December 23, 1985, p. 16. The Air Training Command has apparently received a presentation from Pilatus Aircraft Ltd., of Switzerland on the PC-9, a single-engine, tandem seating, turboprop plane that might be a contender if the Air Force were to relax its twin jet engine, side-by-side seating requirements.

15. See footnote 13.

APPENDIX A

Modification Descriptions

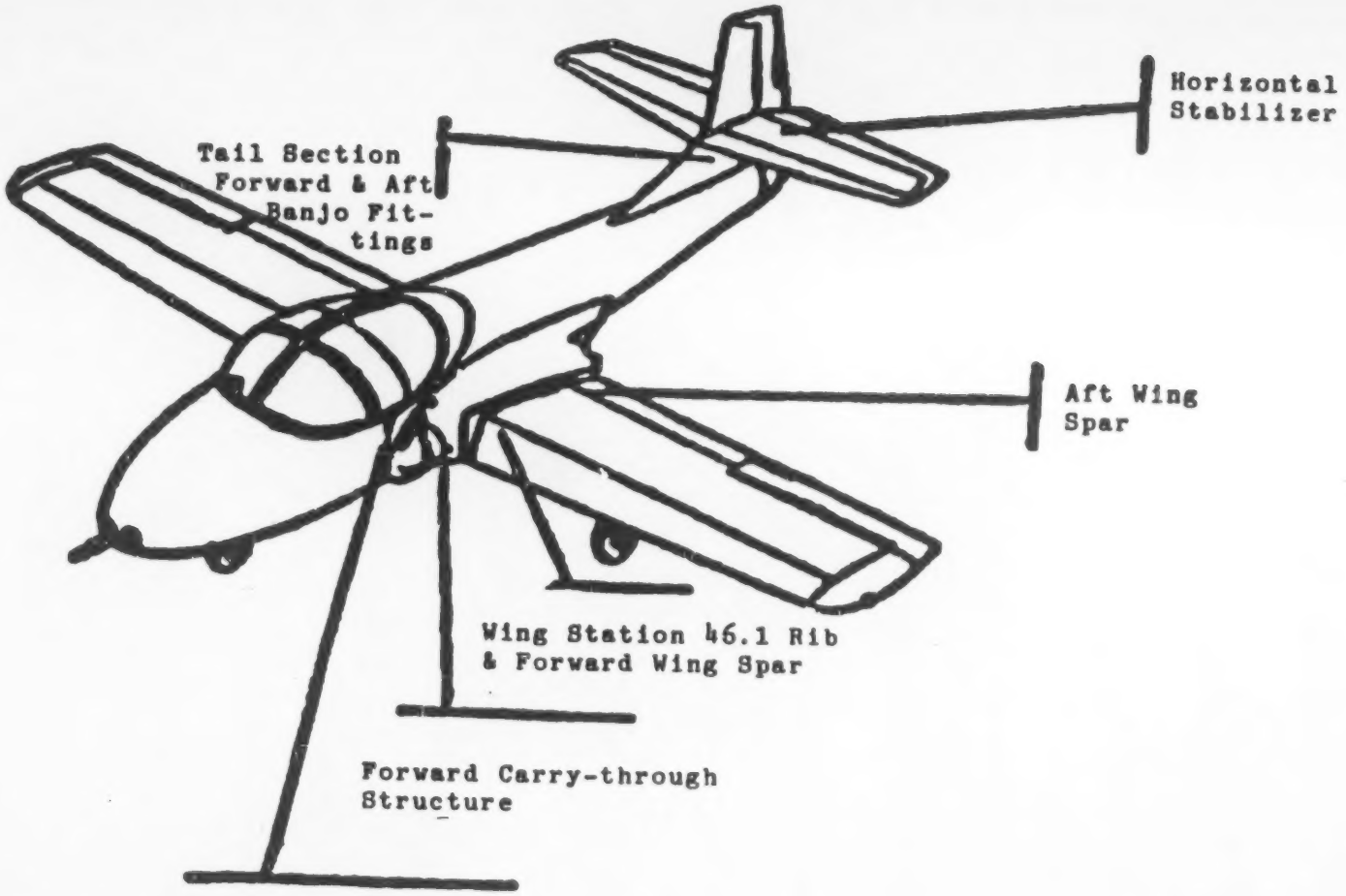
(Options II-IV)

T-37 SERVICE LIFE EXTENSION
Modifications (Six-Pack)

Option II

- Forward Carry-through Structure
- Cockpit Rail
- Wing Station-45.1 Rib and Forward Wing Spar
- Aft Wing Spar
- Forward and Aft Banjo Fitting
- Horizontal Stabilizer

SERVICE LIFE EXTENSION MODIFICATIONS


Horizontal Stabilizer
Tail Section Forward & Aft Banjo Fittings
Aft Wing Spar
Wing Station 46.1 Rib & Forward Wing Spar
Forward Carry-through Structure
Cockpit Rail

MODERNIZATION ALTERNATIVES

Option III—Option II plus:

- Engine Replacement

Option IV—Option III plus:

- Cockpit Pressurization
- Ejection Seats
- Instrument Panel
- Avionics
- Oxygen System
- Environmental Control System

APPENDIX B

Cost Estimates Using Alternative Discount Rates

TABLE B-1. TWENTY-YEAR COSTS OF ALTERNATIVES a/
(Assuming 3 percent discount rate)

	Alternative	Investment b/	Operating & Support c/	Total
I.	Continue T-46 Procurement	2.4 d/	4.0	6.4
II.	Modify T-37 to Extend Service Life	0.7	5.3	6.0
III.	Modify and Re-engine T-37	1.4	5.1	6.5
IV A.	Modify, Reengine, and Upgrade T-37	1.7	5.1	6.8
IV B.	(With Higher Utilization)	1.2	4.4	5.6

SOURCE: CBO estimates from Air Force data.

a. In billions of 1986 dollars.

b. Total investment funding for all planes bought.

c. Estimated by CBO from Air Force input factors using the cost-oriented resource estimating model AFR-173-13, assuming a 20-year time period starting in 1987 and going through 2006. CBO assumed that the planes procured under the various alternatives would be phased in as they were delivered. CBO also assumed the varying force sizes and annual operating hours per year shown in Table 3. The TTB estimates used T-39, a twin-engine executive jet now in Air Force inventory, as a proxy for the TTB.

d. Excludes $0.4 billion in 1985 (current dollars) and earlier funding associated with developing the T-46 and buying the first production lot of 10 planes because these funds are already on contract, but includes $0.3 billion appropriated in 1986 (current dollars) for continued development and procurement of 33 planes.

TABLE B-2. TWENTY-YEAR COSTS OF ALTERNATIVES a/
(Assuming 5 percent discount rate)

	Alternative	Investment b/	Operating & Support c/	Total
I.	Continue T-46 Procurement	2.4 d/	3.4	5.8
II.	Modify T-37 to Extend Service Life	0.5	4.5	5.0
III.	Modify and Re-engine T-37	1.2	4.3	5.5
IV A.	Modify, Reengine, and Upgrade T-37	1.4	4.3	5.7
IV B.	(With Higher utilization)	1.0	3.8	4.8

SOURCE: CBO estimates from Air Force data.

a. In billions of 1986 dollars.

b. Total investment funding for all planes bought.

c. Estimated by CBO from Air Force input factors using the cost-oriented resource estimating model AFR-173-13, assuming a 20-year time period starting in 1987 and going through 2006. CBO assumed that the planes procured under the various alternatives would be phased in as they were delivered. CBO also assumed the varying force sizes and annual operating hours per year shown in Table 3. The TTB estimates used T-39, a twin-engine executive jet now in Air Force inventory, as a proxy for the TTB.

d. Excludes $0.4 billion in 1985 (current dollars) and earlier funding associated with developing the T-46 and buying the first production lot of 10 planes because these funds are already on contract, but includes $0.3 billion appropriated in 1986 (current dollars) for continued development and procurement of 33 planes.